Video and Logger *Pro*
A Guide to Getting Started

Introduction

Logger *Pro* software is an easy-to-use program designed to help students collect, display and analyze data in math and science courses. Data can be collected with an attached interface such as a LabPro, or data can be imported from a TI graphing calculator or a Palm OS handheld. Data can be displayed in a variety of ways including graphs, tables, histograms, fast Fourier transforms, etc. Powerful analysis tools allow students to display and analyze data. One of the most exciting features of Logger *Pro* is the ability to incorporate digital video within the program. Two significant uses of this feature are:

1) A movie can be recorded while sensor-based data are collected. The movie can then be inserted into Logger *Pro*, synchronized with the data, and then replayed for further analysis. For example you can use a motion detector to record the motion of a mass on the end of a spring as it undergoes simple harmonic motion. At the same time you can record a video of that same experiment. The data and the movie can then be synchronized and replayed in Logger *Pro* to answer questions such as: Where was the mass when it had maximum speed? Where was the mass when it had minimum speed?
2) A movie can be recorded and inserted into Logger *Pro* for direct video analysis. This use is independent of any data collection equipment, because motion data are collected directly from the movie itself. For example you can record a movie of a ball being tossed at a 45° angle. Video analysis allows you to record the position of the ball in each frame of the video. Time information is obtained from each frame. These data allow you to compare horizontal versus vertical motion and to determine vertical and horizontal velocity and acceleration.

Both of these uses are very exciting and lead to numerous educational opportunities. However, since most science and math teachers have little experience taking and importing movies into a computer, we are asked many questions about this process. Those questions include:

What types of video files are supported in Logger *Pro*?
What are the basic steps to import a movie into a computer?
What are the computer requirements?
What equipment can be used to record the video?
How do you capture the video?
What are some of the hurdles one can expect and how are they solved?
How is a movie inserted into Logger *Pro*?
How is the movie synchronized to sensor data?
How do you perform motion analysis directly from the movie?

The purpose of this document is to answer these questions and to prepare you and your students to record movies and use them in your classes.

What types of video files are supported in Logger *Pro*?

Logger *Pro* supports any movie that can be played in QuickTime. This includes MOV, AVI, MPEG and most other popular video formats. If you are creating your own movies, you will probably be creating them in one of these formats, in which case they will work within Logger *Pro*. The one common format that is not supported in Logger *Pro* is Windows Media Player.

What are the basic steps to import a movie into a computer?

The following are the basic steps to record a movie and prepare it for use with Logger *Pro* software. More detail information will appear later in this document. You may not need to follow all of these steps, depending upon the equipment that you use and the final use of the movie.

- Shoot the movie – There are a number of ways to obtain a movie. You can shoot them with a digital video camera, a digital still camera that has a movie mode, or a web camera. You can also use analog videos, but you will have to digitize them.
- Get the video into computer – The method of getting the movie into the computer depends upon the camera. A web camera is used while connected to a computer. The movies are therefore saved directly to the computer's hard drive. The movie recorded with a digital video camera is usually transferred from the camera to the computer through a FireWire (IEE1394 or iLink) connection. When a movie is recorded on a digital still camera the movie is saved onto a removable storage media such as compact flash. The movie can then be transferred directly from the camera to the computer with a USB cable or by connecting the removable media to a card reader. The best transfer method should be described in the camera's user's manual.
- Possibly trim the movie – If the movie is long, it may be desirable to trim the movie. Trimming is a process that removes unwanted frames before and/or after the region of interest.
- Maybe de-interlace the movie – Most digital video cameras produce interlaced movies. Interlacing, which will be explained later, can present problems when viewing and analyzing movies of fast moving objects. It may be desirable to de-interlace your movie.
- Maybe compress it – Movie files can be very large. A one minute movie can take up several Mbytes of hard disc space. If you plan to record relatively long movies or share them over the internet, you may want to compress the movie file.
- Add text and/or graphics – You may want to add text or graphics to your movies. This will require separate software.

- Insert into Logger *Pro* and analyze – Once you have completed the above steps, you will then want to insert the movie into Logger *Pro*. This is a simple procedure, which will be explained later. The Logger *Pro* software on line help explains the process and Logger *Pro* has three tutorials that show you how to insert a movie, synchronize data to a movie and perform direct motion analysis.

What are the Computer Requirements?

This is a difficult question to answer because it depends upon the equipment that you use to capture the video. In general to replay movies on a computer, you will need a fairly fast computer with sufficient RAM and hard disk space. For this simple use, we recommend the computer requirements for Logger *Pro* software. Those requirements are

Macintosh computers capable of running one of the following operating systems
Mac OS 9.2 or Mac OS X native (10.2 & 10.3)

Windows computers capable of running one of the following operating systems
Windows 98, ME, NT, 2000, or XP

If you plan to use a digital video camera, the system requirements will be higher. The following represent a good system to work with.

Macintosh computers
- OS X operating system
- 500 MHz G3 processor
- 512 MB RAM
- 20 GB hard drive

Windows computers
- Windows XP
- 1 GHz processor
- 512 MB RAM
- 32 MB video RAM
- FireWire (Many PCs do not come with FireWire, but it is easy and inexpensive to add to the computer whether it is a desktop or laptop computer.)
- 20 GB hard drive

What equipment can be used to record the video?

You have four options when it comes to equipment that can record a video – digital video camera, still digital camera that has a movie mode, Web camera, and analog video camera. The advantages and disadvantages of the first three options are described below. The last option, analog video cameras, is not described because it requires additional equipment.

Digital video cameras

Advantages

Since digital video cameras are stand-alone device, they do not need to be connected to a computer to record a video. Their portability allows them to be used remotely at sites such as playgrounds, amusement parks, athletic fields, etc. Digital video cameras have higher resolution than other options, their optics are better, and they can produce a sharp image. They also allow you to set the shutter speed, which is important for fast moving object. Digital video cameras support frame rates of about 30 frames/second (fps). With deinterlacing software (see below), you can get movies that have frame rates of 60 fps.

Disadvantages

Digital video cameras can be expensive. Compared to web cameras, they take an extra step to get the video into the computer. If you are recording fast moving objects, e.g. carts on tracks, athletes, basketballs, etc., you may have to deal with interlacing effects. To understand interlacing, you need to realize that video is usually drawn as a set of horizontal lines. The horizontal lines are drawn in two separate passes, not one. Every other line is drawn on each consecutive pass, and each of these passes is called a field. When the video is played, the two fields are displayed consecutively on the screen, and they produce a sharp image and smooth non-jerky motion. However when a video is analyzed frame by frame, missing horizontal slices of fast moving objects can be seen on separate fields. This distortion complicates video analysis. If your video has interlacing and you want to get rid of it, you might have to purchase another piece of software, such as VideoPoint Capture, available from Vernier.

Still digital cameras in movie mode

Advantages

Still digital cameras with a movie mode are also portable and are generally less expensive than digital video cameras. If you already have one, this would be an easy way to get started. Since the movie is recorded on some type of removable media, e.g. compact flash, it is easy to load the movie into the computer by simply dragging the file from the removable media to your computer. Also still digital cameras usually have USB connection, which can be used to transfer the movie directly from the camera to the computer.

Disadvantage

Still digital cameras usually do not have as high a resolution as digital video cameras. Their images may not be as sharp, and they lack shutter speed control. The frame rate is probably 15 fps.

Web cameras

Advantages

The quality of newer web cameras is surprisingly good, and they are relatively inexpensive. The movie itself is recorded directly to the computer hard drive. With other camera types, you record the movie and then have to get it from the camera to the computer. We have experimented with the Logitech (www.logitech.com) line of video cameras including the Logitech QuickCam Pro 4000 camera and Logitech QuickCam Zoom. The Logitech Windows video capture software is very flexible, and it allows you to set the shutter speed.

Disadvantages

In theory, web cameras can record at 30 fps, but your final frame rate may be less, depending upon your computer system and the resolution you choose. Most web cameras have to be connected to the computer, so this option is not as portable as a digital video camera or a still digital camera in the video mode. Some inexpensive web cameras have poor optics, which may distort the image.

How to capture the video?

Web Camera

If you use a web camera to record a video, the file will be captured and stored directly on the computer. At this point, you may want to trim the video. If your software does not support trimming, you can use either QuickTime Pro (www.apple.com/quicktime/) or VideoPoint Capture. (More information about VideoPoint Capture appears later.)

Still Digital Cameras in Movie Mode

When you record a movie on a still digital camera, the movie exists as a separate file. Once that file is transferred to the computer, you can begin working with it. At this point, you may want to trim the video. If your software does not support trimming, you can use either QuickTime Pro or VideoPoint Capture.

Digital Video Cameras

When you use a digital video camera, the chances are that the region of interest is simply part of the entire movie or tape, and you will want to capture that region. Most digital video cameras ship with software that allows you to capture regions of video. The exact capture process will depend upon your equipment. More than likely you will connect your camera to the computer with a FireWire cable, and then start your video capture software. The software will have controls that allow you to select only the part of the video that you want. You will then be able to save that section of video as a file, and then use it in Logger *Pro*. As mentioned earlier, interlacing may be problem especially if you are recording fast moving object. You may need to de-interlace the movie, and this will probably require separate software such as QuickTime Pro or VideoPoint Capture.

What are some of the hurdles one can expect and how are they solved?

Trimming
You may want to trim your movie to eliminate extra frames. This is especially true if you are creating a video for video analysis. If your video capture software does not support trimming, you have a couple software options. (1) QuickTime Pro from Apple is very inexpensive program that supports trimming and is available for Mac and Windows computers. (2) VideoPoint Capture is an affordable program that supports trimming and includes many other features for video analysis.

Compressing
If you plan to distribute your movies over the internet or if your movie is very long, you will probably want to compress the video, because video files can be very large. QuickTime Pro and VideoPoint Capture can both be used to compress the video.

How do you insert a movie into Logger *Pro*?

The process of inserting a movie into Logger *Pro* is very easy. First you should copy the file or save the file into the Logger *Pro* Experiments folder. That will make it easier to find the file when you insert it. After the file is saved onto your computer, start Logger *Pro*, pull down the Insert menu and choose Movie. A dialog box will appear from which you can choose your movie. This process is described in a Logger *Pro* tutorial, called "11-1 Working with Movies", which can be found in the Tutorial folder of Logger *Pro*.

It is important to realize that Logger *Pro* does not actually copy the movie into a Logger *Pro* file. Instead Logger *Pro* simply points to the movie file's location. To avoid confusion, we recommend that you keep the movie on your hard drive.

How to synchronize?

If you recorded a video while data collection equipment was being used, you probably want to be able to synchronize the movie with the experiment. This is a simple process and there a couple ways that it can be done. Instead of describing that process, please try the "11-1 Working with Movies" and "11-2 Working with Movies" tutorials in Logger *Pro*.

How to perform motion analysis directly from the movie?

Direct motion analysis from a video, a process commonly called "video analysis" can be performed with Logger *Pro*. In this process you click on an object in a frame of a video. The software records the x- and y-coordinates of that point and the corresponding time. The data are stored in a data table and displayed on a graph. The software then advances the video and the process can be repeated. In the end a record of the object's position coordinates and time are available for further analysis. You can try out this process in the Logger *Pro* tutorial called "12 Video Analysis".

Suggestions

Windows First Time Users
If this is your first venture into working with videos, you are probably wondering where to begin. If you simply want to "test the waters", we recommend starting with a web camera or a digital still camera that has a movie mode. Both of these options are less expensive, and it is relatively easy to get a movie onto your computer and into Logger *Pro*.

If you decide to use a web camera and are using a Windows computer, we recommend the Logitech QuickCam Pro 4000 or the Logitech QuickCam Zoom camera. They are each under $100, and they come with capture software. If you go this route and want to trim your video, we recommend purchasing QuickTime Pro or VideoPoint Capture.

Also if you go this route, you will need to update your version of QuickTime by downloading a codec required by the Logitech software. That codec is available on the Apple web site at http://docs.info.apple.com/article.html?artnum=60369. Download this file and install it on your computer before trying to inserting the movie into Logger *Pro*.

Macintosh First Time Users
If you are using a Macintosh computer, you might want to consider the Logitech web cameras (see above).

Experienced Users
If you are familiar with capturing videos, you probably do not need help with the mechanics of creating a video file. Instead you may need practice in using your videos with Logger *Pro*. If that is the case, we recommend that you try the Logger *Pro* tutorials entitled "11-1 Working with Movies", "11-2 Working with Movies", and "12 Video Analysis".

VideoPoint Capture
If you decide to record and analyze your own movies, VideoPoint Capture software simplifies capturing video from digital sources and converting them into analyzable movies. VideoPoint Capture is compatible with most video capture hardware on both the Macintosh and Windows platforms and is available from Vernier (www.vernier.com/soft/videopoint.html). Important features of VideoPoint Capture include:

- Elimination of most instances of frames dropped during the capture process. (It also lets you know when you have irregular time steps.)
- The ability to add annotations and images to video frames.
- The ability to get rid of duplicated frames created during video capturing.
- De-interlacing of video to get 60 fps which is great for movies of projectiles, toys or sports. (This assumes that your hardware captures both even and odd fields.)

- The ability to make a frame rate correction. (If the original video was shot at a rate other than 30 fps and then transferred to a 30 fps video, you can correct the frame rate to get the correct original times.)
- The ability to eliminate extra frames generated when movies are transferred to digital video.

VideoPoint
Logger *Pro* software has basic video analysis features. If you are interested in advanced video analysis, you might be interested in purchasing VideoPoint software (www.vernier.com/soft/videopoint.html). Important features of VideoPoint include:

- Support for fixed, moving, transformed or multiple coordinate systems.
- Support for angular measurement.
- Support for Polar and Cartesian coordinate systems.
- Scaling features; e.g. fixed, adjustable, or multiple.
- Scales that change for zooming cameras.
- An extensive library of videos that can be analyzed.

References

LivePhoto Physics Project (http://livephoto.rit.edu/)

Pat Cooney's web site (http://muweb.millersville.edu/~pjcooney/making-movies/)